Complete Summary

GUIDELINE TITLE

Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings, 2005.

BIBLIOGRAPHIC SOURCE(S)

Jensen PA, Lambert LA, Iademarco MF, Ridzon R. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 2005. MMWR Recomm Rep 2005 Dec 30;54(17):1-141. [487 references] PubMed

GUIDELINE STATUS

This is the current release of the guideline.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Tuberculosis (TB)

GUIDELINE CATEGORY

Diagnosis
Evaluation
Management
Prevention
Risk Assessment
Screening

CLINICAL SPECIALTY

Family Practice
Infectious Diseases
Internal Medicine
Pediatrics
Preventive Medicine
Pulmonary Medicine

INTENDED USERS

Advanced Practice Nurses
Clinical Laboratory Personnel
Health Care Providers
Hospitals
Nurses
Physician Assistants
Physicians
Public Health Departments
Respiratory Care Practitioners
Utilization Management

GUIDELINE OBJECTIVE(S)

To reassess and update tuberculosis (TB) control recommendations to reflect shifts in the epidemiology of TB, advances in scientific understanding, and changes in health-care practice that have occurred in the United States during the preceding decade

TARGET POPULATION

- Patients and health-care workers with suspected or confirmed tuberculosis (TB) or latent TB infection (LTBI)
- People in health-care settings who are at risk for TB

INTERVENTIONS AND PRACTICES CONSIDERED

1. Tuberculosis (TB) risk assessment and classification depending on the type of setting
    - TB screening (tuberculin skin test [TST], blood assay for *Mycobacterium tuberculosis* [BAMT), chest radiograph, symptom screen, laboratory tests, bronchoscopy)
2. Identification of problems in the TB infection-control procedures
3. Management of patients who have suspected or confirmed disease including considerations for special circumstances and settings
    - Triage
    - TB airborne precautions
    - Airborne infection isolation (AII) room practices
    - Diagnostic procedures
    - Treatment (isoniazid, rifampin, rifampin/pyrazinamide) using directly observed therapy
    - Management in inpatient settings
    - Management in outpatient settings
4. Training and educating health-care workers (HCWs)

5. TB infection-control surveillance
6. Collaboration with the local or state health department
7. Environmental controls
8. Respiratory protection

MAJOR OUTCOMES CONSIDERED

- Infectiousness of a TB patient
- Effectiveness of environmental controls and respiratory protection

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

Not stated

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Not stated

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not applicable

METHODS USED TO ANALYZE THE EVIDENCE

Review
Review of Published Meta-Analyses

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Not stated

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Not stated

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Note from the National Guideline Clearinghouse (NGC): The recommendations in this report update tuberculosis (TB) control recommendations reflecting shifts in the epidemiology of TB, advances in scientific understanding, and changes in health-care practice that have occurred in the United States during the preceding decade. This report replaces all previous Centers for Disease Control and Prevention (CDC) guidelines on TB infection control in health-care settings. For a description of all changes that differentiate this report from previous guidelines, refer to the original guideline document.

Recommendations for Preventing Transmission of *Mycobacterium tuberculosis* in Health-Care Settings

TB Infection-Control Program

Every health-care setting should have a TB infection-control plan that is part of an overall infection-control program. The specific details of the TB infection-control program will differ, depending on whether patients with suspected or confirmed TB disease might be encountered in the setting or whether patients with suspected or confirmed TB disease will be transferred to another health-care setting. Administrators making this distinction should obtain medical and epidemiologic consultation from state and local health departments.

TB Infection-Control Program for Settings in Which Patients with Suspected or Confirmed TB Disease Are Expected To Be Encountered

The TB infection-control program should consist of administrative controls, environmental controls, and a respiratory-protection program. Every setting in which services are provided to persons who have suspected or confirmed infectious TB disease, including laboratories and nontraditional facility-based settings, should have a TB infection-control plan. The following steps should be taken to establish a TB infection-control program in these settings:

1. Assign supervisory responsibility for the TB infection-control program to a designated person or group with expertise in latent TB infection (LTBI) and TB disease, infection control, occupational health, environmental controls, and respiratory protection. Give the supervisor or supervisory body the support and authority to conduct a TB risk assessment, implement and enforce TB infection-control policies, and ensure recommended training and education of health-care workers (HCWs).
    - Train the persons responsible for implementing and enforcing the TB infection-control program.
    - Designate one person with a back-up as the TB resource person to whom questions and problems should be addressed, if supervisory responsibility is assigned to a committee.
2. Develop a written TB infection-control plan that outlines a protocol for the prompt recognition and initiation of airborne precautions of persons with suspected or confirmed TB disease, and update it annually.
3. Conduct a problem evaluation (see "Problem Evaluation" below) if a case of suspected or confirmed TB disease is not promptly recognized and appropriate airborne precautions not initiated, or if administrative, environmental, or respiratory-protection controls fail.
4. Perform a contact investigation in collaboration with the local or state health department if health-care-associated transmission of *M. tuberculosis* is suspected (Centers for Disease Control and Prevention [CDC], "Effective TB interviewing," 2004). Implement and monitor corrective action.
5. Collaborate with the local or state health department to develop administrative controls consisting of the risk assessment, the written TB infection-control plan, management of patients with suspected or confirmed TB disease, training and education of HCWs, screening and evaluation of HCWs, problem evaluation, and coordination.
6. Implement and maintain environmental controls, including airborne infection isolation (AII) room(s) (see Supplement, "Environmental Controls" in the original guideline document).
7. Implement a respiratory-protection program.
8. Perform ongoing training and education of HCWs (see "Suggested Components of an Initial TB Training and Education Program for HCWs" in the original guideline document).
9. Create a plan for accepting patients who have suspected or confirmed TB disease if they are transferred from another setting.

TB Infection-Control Program for Settings in Which Patients with Suspected or Confirmed TB Disease Are Not Expected To Be Encountered

Settings in which TB patients might stay before transfer should still have a TB infection-control program in place consisting of administrative, environmental, and respiratory-protection controls. The following steps should be taken to establish a TB infection-control program in these settings:

1. Assign responsibility for the TB infection-control program to appropriate personnel.
2. Develop a written TB infection-control plan that outlines a protocol for the prompt recognition and transfer of persons who have suspected or confirmed TB disease to another health-care setting. The plan should indicate procedures to follow to separate persons with suspected or confirmed

infectious TB disease from other persons in the setting until the time of transfer. Evaluate the plan annually, if possible, to ensure that the setting remains one in which persons who have suspected or confirmed TB disease are not encountered and that they are promptly transferred.
3. Conduct a problem evaluation (see "Problem Evaluation" below) if a case of suspected or confirmed TB disease is not promptly recognized, separated from others, and transferred.
4. Perform an investigation in collaboration with the local or state health department if health-care-associated transmission of *Mycobacterium tuberculosis* (*M. tuberculosis*) is suspected.
5. Collaborate with the local or state health department to develop administrative controls consisting of the risk assessment and the written TB infection-control plan.

TB Risk Assessment

Every health-care setting should conduct initial and ongoing evaluations of the risk for transmission of *M. tuberculosis*, regardless of whether or not patients with suspected or confirmed TB disease are expected to be encountered in the setting. The TB risk assessment determines the types of administrative, environmental, and respiratory-protection controls needed for a setting and serves as an ongoing evaluation tool of the quality of TB infection control and for the identification of needed improvements in infection-control measures. Part of the risk assessment is similar to a program review that is conducted by the local TB-control program (CDC, "Core curriculum," 2000). The TB Risk Assessment Worksheet (refer to Appendix B in the original guideline document) can be used as a guide for conducting a risk assessment. This worksheet frequently does not specify values for acceptable performance indicators because of the lack of scientific data.

TB Risk Assessment for Settings in Which Patients with Suspected or Confirmed TB Disease Are Expected To Be Encountered

The initial and ongoing risk assessment for these settings should consist of the following steps:

1. Review the community profile of TB disease in collaboration with the state or local health department.
2. Consult the local or state TB-control program to obtain epidemiologic surveillance data necessary to conduct a TB risk assessment for the health-care setting.
3. Review the number of patients with suspected or confirmed TB disease who have been encountered in the setting during at least the previous 5 years.
4. Determine if persons with unrecognized TB disease have been admitted to or were encountered in the setting during the previous 5 years.
5. Determine which HCWs need to be included in a TB screening program and the frequency of screening (based on risk classification) (see Appendix C in the original guideline document).
6. Ensure the prompt recognition and evaluation of suspected episodes of health-care-associated transmission of *M. tuberculosis*.
7. Identify areas in the setting with an increased risk for health-care-associated transmission of *M. tuberculosis*, and target them for improved TB infection controls.

8. Assess the number of AII rooms needed for the setting. The risk classification for the setting should help to make this determination, depending on the number of TB patients examined. At least one AII room is needed for settings in which TB patients stay while they are being treated, and additional AII rooms might be needed, depending on the magnitude of patient-days of cases of suspected or confirmed TB disease. Additional AII rooms might be considered if options are limited for transferring patients with suspected or confirmed TB disease to other settings with AII rooms.
9. Determine the types of environmental controls needed other than AII rooms (see "TB Airborne Precautions" below).
10. Determine which HCWs need to be included in the respiratory-protection program.
11. Conduct periodic reassessments (annually, if possible) to ensure
    - proper implementation of the TB infection-control plan
    - prompt detection and evaluation of suspected TB cases
    - prompt initiation of airborne precautions of suspected infectious TB cases
    - recommended medical management of patients with suspected or confirmed TB disease ("Treatment of tuberculosis," 2003)
    - functional environmental controls
    - implementation of the respiratory-protection program, and
    - ongoing HCW training and education regarding TB
12. Recognize and correct lapses in infection control.

TB Risk Assessment for Settings in Which Patients with Suspected or Confirmed TB Disease Are Not Expected To Be Encountered

The initial and ongoing risk assessment for these settings should consist of the following steps:

1. Review the community profile of TB disease in collaboration with the local or state health department.
2. Consult the local or state TB-control program to obtain epidemiologic surveillance data necessary to conduct a TB risk assessment for the health-care setting.
3. Determine if persons with unrecognized TB disease were encountered in the setting during the previous 5 years.
4. Determine if any HCWs need to be included in the TB screening program.
5. Determine the types of environmental controls that are currently in place, and determine if any are needed in the setting (see "Environmental Controls"; Appendices A and D in the original guideline document).
6. Document procedures that ensure the prompt recognition and evaluation of suspected episodes of health-care-associated transmission of *M. tuberculosis*.
7. Conduct periodic reassessments (annually, if possible) to ensure 1) proper implementation of the TB infection-control plan; 2) prompt detection and evaluation of suspected TB cases; 3) prompt initiation of airborne precautions of suspected infectious TB cases before transfer; 4) prompt transfer of suspected infectious TB cases; 5) proper functioning of environmental controls, as applicable; and 6) ongoing TB training and education for HCWs.
8. Recognize and correct lapses in infection control.

Use of Risk Classification to Determine Need for TB Screening and Frequency of Screening HCWs

Risk classification should be used as part of the risk assessment to determine the need for a TB screening program for HCWs and the frequency of screening (see Appendix C in the original guideline document). A risk classification usually should be determined for the entire setting. However, in certain settings (e.g., health-care organizations that encompass multiple sites or types of services), specific areas defined by geography, functional units, patient population, job type, or location within the setting might have separate risk classifications. Examples of assigning risk classifications have been provided in the original guideline document.

TB Screening Risk Classifications

The three TB screening risk classifications are low risk, medium risk, and potential ongoing transmission. The classification of low risk should be applied to settings in which persons with TB disease are not expected to be encountered, and, therefore, exposure to *M. tuberculosis* is unlikely. This classification should also be applied to HCWs who will never be exposed to persons with TB disease or to clinical specimens that might contain *M. tuberculosis*.

The classification of medium risk should be applied to settings in which the risk assessment has determined that HCWs will or will possibly be exposed to persons with TB disease or to clinical specimens that might contain *M. tuberculosis*.

The classification of potential ongoing transmission should be temporarily applied to any setting (or group of HCWs) if evidence suggestive of person-to-person (e.g., patient-to-patient, patient-to-HCW, HCW-to-patient, or HCW-to-HCW) transmission of *M. tuberculosis* has occurred in the setting during the preceding year. Evidence of person-to-person transmission of *M. tuberculosis* includes 1) clusters of tuberculin skin test (TST) or blood assay for *M. tuberculosis* (BAMT) conversions, 2) HCW with confirmed TB disease, 3) increased rates of TST or BAMT conversions, 4) unrecognized TB disease in patients or HCWs, or 5) recognition of an identical strain of *M. tuberculosis* in patients or HCWs with TB disease identified by deoxyribonucleic acid (DNA) fingerprinting.

If uncertainty exists regarding whether to classify a setting as low risk or medium risk, the setting typically should be classified as medium risk.

TB Screening Procedures for Settings (or HCWs) Classified as Low Risk

- All HCWs should receive baseline TB screening upon hire, using two-step TST or a single BAMT to test for infection with *M. tuberculosis*.
- After baseline testing for infection with *M. tuberculosis*, additional TB screening is not necessary unless an exposure to *M. tuberculosis* occurs.
- HCWs with a baseline positive or newly positive test result for *M. tuberculosis* infection (i.e., TST or BAMT) or documentation of treatment for LTBI or TB disease should receive one chest radiograph result to exclude TB disease (or an interpretable copy within a reasonable time frame, such as 6 months). Repeat radiographs are not needed unless symptoms or signs of TB disease

develop or unless recommended by a clinician ("Targeted tuberculin testing," 2000; Food and Drug Administration, 1983).

TB Screening Procedures for Settings (or HCWs) Classified as Medium Risk

- All HCWs should receive baseline TB screening upon hire, using two-step TST or a single BAMT to test for infection with *M. tuberculosis*.
- After baseline testing for infection with *M. tuberculosis*, HCWs should receive TB screening annually (i.e., symptom screen for all HCWs and testing for infection with *M. tuberculosis* for HCWs with baseline negative test results).
- HCWs with a baseline positive or newly positive test result for *M. tuberculosis* infection or documentation of previous treatment for LTBI or TB disease should receive one chest radiograph result to exclude TB disease. Instead of participating in serial testing, HCWs should receive a symptom screen annually. This screen should be accomplished by educating the HCW about symptoms of TB disease and instructing the HCW to report any such symptoms immediately to the occupational health unit. Treatment for LTBI should be considered in accordance with CDC guidelines ("Targeted tuberculin testing," 2000).

TB Screening Procedures for Settings (or HCWs) Classified as Potential Ongoing Transmission

- Testing for infection with *M. tuberculosis* might need to be performed every 8 to 10 weeks until lapses in infection control have been corrected, and no additional evidence of ongoing transmission is apparent.
- The classification of potential ongoing transmission should be used as a temporary classification only. It warrants immediate investigation and corrective steps. After a determination that ongoing transmission has ceased, the setting should be reclassified as medium risk. Maintaining the classification of medium risk for at least 1 year is recommended.

Settings Adopting BAMT for Use in TB Screening

Settings that use TST as part of TB screening and want to adopt BAMT can do so directly (without any overlapping TST) or in conjunction with a period of evaluation (e.g., 1 or 2 years) during which time both TST and BAMT are used. Baseline testing for BAMT would be established as a single step test. As with the TST, BAMT results should be recorded in detail. The details should include date of blood draw, result in specific units, and the laboratory interpretation (positive, negative, or indeterminate - and the concentration of cytokine measured, for example, interferon-gamma).

Refer to the original guideline document for examples of risk classification.

Screening HCWs Who Transfer to Other Health-Care Settings

All HCWs should receive baseline TB screening, even in settings considered to be low risk. Infection-control plans should address HCWs who transfer from one health-care setting to another and consider that the transferring HCWs might be at an equivalent or higher risk for exposure in different settings. Infection-control

plans might need to be customized to balance the assessed risks and the efficacy of the plan based on consideration of various logistical factors. Guidance is provided based on different scenarios.

Because some institutions might adopt BAMT for the purposes of testing for *M. tuberculosis* infection, infection-control programs might be confronted with interpreting historic and current TST and BAMT results when HCWs transfer to a different setting. On a case-by-case basis, expert medical opinion might be needed to interpret results and refer patients with discordant BAMT and TST baseline results. Therefore, infection-control programs should keep all records when documenting previous test results. For example, an infection-control program using a BAMT strategy should request and keep historic TST results of a HCW transferring from a previous setting. Even if the HCW is transferring from a setting that used BAMT to a setting that uses BAMT, historic TST results might be needed when in the future the HCW transfers to a setting that uses TST. Similarly, historic BAMT results might be needed when the HCW transfers from a setting that used TST to a setting that uses BAMT.

HCWs transferring from low-risk to low-risk settings. After a baseline result for infection with *M. tuberculosis* is established and documented, serial testing for *M. tuberculosis* infection is not necessary.

HCWs transferring from low-risk to medium-risk settings. After a baseline result for infection with *M. tuberculosis* is established and documented, annual TB screening (including a symptom screen and TST or BAMT for persons with previously negative test results) should be performed.

HCWs transferring from low- or medium-risk settings to settings with a temporary classification of potential ongoing transmission. After a baseline result for infection with *M. tuberculosis* is established, a decision should be made regarding follow-up screening on an individual basis. If transmission seems to be ongoing, consider including the HCW in the screenings every 8 to 10 weeks until a determination has been made that ongoing transmission has ceased. When the setting is reclassified back to medium-risk, annual TB screening should be resumed.

Refer to the original guideline document for calculation and use of conversion rates for *M. tuberculosis* infection, use of conversion test data for *M. tuberculosis* infection to identify lapses in infection control, and example calculations of conversion rates.

Evaluation of Tuberculosis (TB) Infection-Control Procedures and Identification of Problems

Annual evaluations of the TB infection-control plan are needed to ensure the proper implementation of the plan and to recognize and correct lapses in infection control. Previous hospital admissions and outpatient visits of patients with TB disease should be noted before the onset of TB symptoms. Medical records of a sample of patients with suspected and confirmed TB disease who were treated or examined at the setting should be reviewed to identify possible problems in TB infection control. The review should be based on the factors listed on the TB Risk Assessment Worksheet (see Appendix B in the original guideline).

- Time interval from suspicion of TB until initiation of airborne precautions and antituberculosis treatment
    - suspicion of TB disease and patient triage to proper AII room or referral center for settings that do not provide care for patients with suspected or confirmed TB disease
    - admission until TB disease was suspected
    - admission until medical evaluation for TB disease was performed
    - admission until specimens for acid-fast bacilli (AFB) smears and polymerase chain reaction (PCR)-based nucleic acid amplification (NAA) tests for *M. tuberculosis* were ordered
    - admission until specimens for mycobacterial culture were ordered
    - ordering of AFB smears, nucleic acid amplification (NAA) tests, and mycobacterial culture until specimens were collected
    - collection of specimens until performance and AFB smear results were reported
    - collection of specimens until performance and culture results were reported
    - collection of specimens until species identification was reported
    - collection of specimens until drug-susceptibility test results were reported
    - admission until airborne precautions were initiated
    - admission until antituberculosis treatment was initiated
- Duration of airborne precautions
- Measurement of meeting criteria for discontinuing airborne precautions. Certain patients might be correctly discharged from an AII room to home
- Patient history of previous admission
- Adequacy of antituberculosis treatment regimens
- Adequacy of procedures for collection of follow-up sputum specimens
- Adequacy of discharge planning
- Number of visits to outpatient setting from the start of symptoms until TB disease was suspected (for outpatient settings)

Work practices related to airborne precautions should be observed to determine if employers are enforcing all practices, if health-care workers (HCWs) are adhering to infection-control policies, and if patient adherence to airborne precautions is being enforced. Data from the case reviews and observations in the annual risk assessment should be used to determine the need to modify 1) protocols for identifying and initiating prompt airborne precautions for patients with suspected or confirmed infectious TB disease, 2) protocols for patient management, 3) laboratory procedures, or 4) TB training and education programs for HCWs.

Environmental Assessment

- Data from the most recent environmental evaluation should be reviewed to determine if recommended environmental controls are in place (see "Suggested Components of an Initial TB Training and Education Program for HCWs" in the original guideline document).
- Environmental control maintenance procedures and logs should not be reviewed to determine if maintenance is conducted properly and regularly.
- Environmental control design specifications should be compared with guidelines from the American Institute of Architects (AIA) and other ventilation guidelines (American Society for Heating, Refrigerating and Air-

Conditioning Engineers, 2003; AIA, 2001) (see "Risk Classification Examples" in the original guideline document) and the installed system performance.
- Environmental data should be used to assist building managers and engineers in evaluating the performance of the installed system.
- The number and types of aerosol-generating or aerosol-producing procedures (e.g., specimen processing and manipulation, bronchoscopy, sputum induction, and administration of aerosolized medications) performed in the setting should be assessed.
- The number of AII rooms should be suitable for the setting based on AIA Guidelines and the setting risk assessment. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has adapted the AIA guidelines when accrediting facilities (AIA, 2001).

Refer to the original guideline document for information regarding suggested components of an initial TB training and education programs for HCWs.

Managing Patients Who Have Suspected or Confirmed TB Disease: General Recommendations

The primary TB risk to HCWs is the undiagnosed or unsuspected patient with infectious TB disease. A high index of suspicion for TB disease and rapid implementation of precautions are essential to prevent and interrupt transmission. Specific precautions will vary depending on the setting.

Prompt Triage

Within health-care settings, protocols should be implemented and enforced to promptly identify, separate from others, and either transfer or manage persons who have suspected or confirmed infectious TB disease. When patients' medical histories are taken, all patients should be routinely asked about 1) a history of TB exposure, infection, or disease; 2) symptoms or signs of TB disease; and 3) medical conditions that increase their risk for TB disease (see Supplements, "Diagnostic Procedures for Latent tuberculosis infection (LTBI) and TB Disease;" and "Treatment Procedures for LTBI and TB Disease" in the original guideline document). The medical evaluation should include an interview conducted in the patient's primary language, with the assistance of a qualified medical interpreter, if necessary. HCWs who are the first point of contact should be trained to ask questions that will facilitate detection of persons who have suspected or confirmed infectious TB disease. For assistance with language interpretation, contact the local and state health department. Interpretation resources are also available (Francis J. Curry National Tuberculosis Center, 2003) at http://www.atanet.org; http://www.languageline.com; and http://www.ncihc.org.

A diagnosis of respiratory TB disease should be considered for any patient with symptoms or signs of infection in the lung, pleura, or airways (including larynx), including coughing for >3 weeks, loss of appetite, unexplained weight loss, night sweats, bloody sputum or hemoptysis, hoarseness, fever, fatigue, or chest pain. The index of suspicion for TB disease will vary by geographic area and will depend on the population served by the setting. The index of suspicion should be substantially high for geographic areas and groups of patients characterized by high TB incidence (CDC, "Reported tuberculosis," 2005).

Special steps should be taken in settings other than TB clinics. Patients with symptoms suggestive of undiagnosed or inadequately treated TB disease should be promptly referred so that they can receive a medical evaluation. These patients should not be kept in the setting any longer than required to arrange a referral or transfer to an AII room. While in the setting, symptomatic patients should wear a surgical or procedure mask, if possible, and should be instructed to observe strict respiratory hygiene and cough etiquette procedures (see Glossary in the original guideline document) (Lenehan, 2004; Piotrowski, 2003; CDC, "Key facts," 2004).

Immunocompromised persons, including those who are HIV-infected, with infectious TB disease should be physically separated from other persons to protect both themselves and others. To avoid exposing HIV-infected or otherwise severely immunocompromised persons to *M. tuberculosis*, consider location and scheduling issues to avoid exposure.

TB Airborne Precautions

Within health-care settings, TB airborne precautions should be initiated for any patient who has symptoms or signs of TB disease, or who has documented infectious TB disease and has not completed antituberculosis treatment. For patients placed in AII rooms because of suspected infectious TB disease of the lungs, airway, or larynx, airborne precautions may be discontinued when infectious TB disease is considered unlikely and either 1) another diagnosis is made that explains the clinical syndrome or 2) the patient has three consecutive, negative acid-fast bacilli (AFB) sputum smear results (Al Zahrani et al., 2001; Conde et al., 2000; Bell, Leckie, & McKendrick, 2003; Merrick et al., 1997; Leonard et al., 2005). Each of the three sputum specimens should be collected in 8 to 24-hour intervals (Toman, 2004), and at least one specimen should be an early morning specimen because respiratory secretions pool overnight. Generally, this method will allow patients with negative sputum smear results to be released from airborne precautions in 2 days.

The classification of the risk assessment of the health-care setting is used to determine how many AII rooms each setting needs, depending on the number of TB patients examined.

At least one AII room is needed for settings in which TB patients stay while they are being treated, and additional AII rooms might be needed depending on the magnitude of patient-days of persons with suspected or confirmed TB disease (AIA, 2001). Additional rooms might be considered if options are limited for transferring patients with suspected or confirmed TB disease to other settings with AII rooms. For example, for a hospital with 120 beds, a minimum of one AII room is needed, possibly more, depending on how many TB patients are examined in 1 year.

TB Airborne Precautions for Settings in Which Patients with Suspected or Confirmed TB Disease Are Expected To Be Encountered

Settings that plan to evaluate and manage patients with TB disease should have at least one AII room or enclosure that meets AII requirements (see "Environmental Controls below;" and the Supplement, "Environmental Controls" in the original guideline document). These settings should develop written policies

that specify 1) indications for airborne precautions, 2) persons authorized to initiate and discontinue airborne precautions, 3) specific airborne precautions, 4) AII room-monitoring procedures, 5) procedures for managing patients who do not adhere to airborne precautions, and 6) criteria for discontinuing airborne precautions.

A high index of suspicion should be maintained for TB disease. If a patient has suspected or confirmed TB disease, airborne precautions should be promptly initiated. Persons with suspected or confirmed TB disease who are inpatients should remain in AII rooms until they are determined to be noninfectious and have demonstrated a clinical response to a standard multidrug antituberculosis treatment regimen or until an alternative diagnosis is made. If the alternative diagnosis cannot be clearly established, even with three negative sputum smear results, empiric treatment of TB disease should strongly be considered (see Supplement, "Estimating the Infectiousness of a TB Patient" in the original guideline document). Outpatients with suspected or confirmed infectious TB disease should remain in AII rooms until they are transferred or until their visit is complete.

TB Airborne Precautions for Settings in Which Patients with Suspected or Confirmed TB Disease Are Not Expected To Be Encountered

Settings in which patients with suspected or confirmed TB disease are not expected to be encountered do not need an AII room or a respiratory-protection program for the prevention of transmission of *M. tuberculosis*. However, follow the following steps in these settings.

A written protocol should be developed for referring patients with suspected or confirmed TB disease to a collaborating referral setting in which the patient can be evaluated and managed properly. The referral setting should provide documentation of intent to collaborate. The protocol should be reviewed routinely and revised as needed.

Patients with suspected or confirmed TB disease should be placed in an AII room, if available, or in a room that meets the requirements for an AII room, or in a separate room with the door closed, apart from other patients and not in an open waiting area. Adequate time should elapse to ensure removal of *M. tuberculosis*-contaminated room air before allowing entry by staff or another patient (see Supplement, "Environmental Controls;" Tables 1 and 2 in the original guideline document).

If an AII room is not available, persons with suspected or confirmed infectious TB disease should wear a surgical or procedure mask, if possible. Patients should be instructed to keep the mask on and to change the mask if it becomes wet. If patients cannot tolerate a mask, they should observe strict respiratory hygiene and cough etiquette procedures.

AII Room Practices

AII rooms should be single-patient rooms in which environmental factors and entry of visitors and HCWs are controlled to minimize the transmission of *M. tuberculosis*. All HCWs who enter an AII room should wear at least N95 disposable

respirators (see Supplement, "Respiratory Protection" in the original guideline document). Visitors may be offered respiratory protection (i.e., N95) and should be instructed by HCWs on the use of the respirator before entering an AII room. AII rooms have specific requirements for controlled ventilation, negative pressure, and air filtration (AIA, 2001) (see Supplement, "Environmental Controls" in the original guideline document). Each inpatient AII room should have a private bathroom.

Refer to the original guideline document for information on settings with AII rooms.

Diagnostic Procedures

Diagnostic procedures should be performed in settings with appropriate infection-control capabilities. The following recommendations should be applied for diagnosing TB disease and for evaluating patients for potential infectiousness.

Clinical Diagnosis

A complete medical history should be obtained, including symptoms of TB disease, previous TB disease and treatment, previous history of infection with *M. tuberculosis*, and previous treatment of LTBI or exposure to persons with TB disease. A physical examination should be performed, including chest radiograph, microscopic examination, culture, and, when indicated, nucleic acid amplification (NAA) testing of sputum ("Targeted tuberculin testing," 2000; CDC, 1998; "Update: nucleic acid," 2000; Willcox et al., 1986). If possible, sputum induction with aerosol inhalation is preferred, particularly when the patient cannot produce sputum. Gastric aspiration might be necessary for those patients, particularly children, who cannot produce sputum, even with aerosol inhalation (Abadco & Steiner, 1992; Abadco et al., 1992; Chan, Abadco, & Steiner, 1994; Lillehei, 1961). Bronchoscopy might be needed for specimen collection, especially if sputum specimens have been nondiagnostic and doubt exists as to the diagnosis (Pizzichini et al., 2002; Bell, Leckie, & McKendrick, 2003; Abadco & Steiner, 1992; Abadco et al., 1992; Willcox, Benatar, & Portgieter, 1982; Djukanovic et al., 2002; Paggiaro et al., 2002; Gibson et al., 2002).

All patients with suspected or confirmed infectious TB disease should be placed under airborne precautions until they have been determined to be noninfectious (see Supplement, "Estimating the Infectiousness of a TB Patient" in the original guideline document). Adult and adolescent patients who might be infectious include persons who are coughing; have cavitation on chest radiograph; have positive AFB sputum smear results; have respiratory tract disease with involvement of the lung, pleura or airways, including larynx, who fail to cover the mouth and nose when coughing; are not on antituberculosis treatment or are on incorrect antituberculosis treatment; or are undergoing cough-inducing or aerosol-generating procedures (e.g., sputum induction, bronchoscopy, and airway suction) ("Diagnostic standards," 2000; Curtis et al., 1999).

Persons diagnosed with extrapulmonary TB disease should be evaluated for the presence of concurrent pulmonary TB disease. An additional concern in infection control with children relates to adult household members and visitors who might be the source case (American Academy of Pediatrics [AAP], 2003). Pediatric

patients, including adolescents, who might be infectious include those who have extensive pulmonary or laryngeal involvement, prolonged cough, positive sputum AFB smears results, cavitary TB on chest radiograph (as is typically observed in immunocompetent adults with TB disease), or those for whom cough-inducing or aerosol-generating procedures are performed (AAP, 2003; Rabalais, Adams, & Stover, 1991).

Although children are uncommonly infectious, pediatric patients should be evaluated for infectiousness by using the same criteria as for adults (i.e., on the basis of pulmonary or laryngeal involvement). Patients with suspected or confirmed TB disease should be immediately reported to the local public health authorities so that arrangements can be made for tracking their treatment to completion, preferably through a case management system, so that directly observed therapy (DOT) can be arranged and standard procedures for identifying and evaluating TB contacts can be initiated. Coordinate efforts with the local or state health department to arrange treatment and long-term follow-up and evaluation of contacts.

Laboratory Diagnosis

To produce the highest quality laboratory results, laboratories performing mycobacteriologic tests should be skilled in both the laboratory and the administrative aspects of specimen processing. Laboratories should use or have prompt access to the most rapid methods available: 1) fluorescent microscopy and concentration for AFB smears; 2) rapid NAA testing for direct detection of *M. tuberculosis* in patient specimens ("Update: nucleic acid," 2000); 3) solid and rapid broth culture methods for isolation of mycobacteria; 4) nucleic acid probes or high pressure liquid chromatography (HPLC) for species identification; and 5) rapid broth culture methods for drug susceptibility testing. Laboratories should incorporate other more rapid or sensitive tests as they become available, practical, and affordable (see Supplement, "Diagnostic Procedures for LTBI and TB Disease" in the original guideline document) (CDC & National Institutes of Health [NIH], "Agent: *Mycobacterium tuberculosis*," 1999; Association of State and Territorial Public Health Laboratory Directors [ASTPHLD] & CDC, 1995).

In accordance with local and state laws and regulations, a system should be in place to ensure that laboratories report any positive results from any specimens to clinicians within 24 hours of obtaining the result (ASTPHLD & CDC, 1995; Tenover et al., 1993). Certain settings perform AFB smears on-site for rapid results (and results should be reported to clinicians within 24 hours) and then send specimens or cultures to a referral laboratory for identification and drug-susceptibility testing. This referral practice can speed the receipt of smear results but delay culture identification and drug-susceptibility results. Settings that cannot provide the full range of mycobacteriologic testing services should contract with their referral laboratories to ensure rapid results while maintaining proficiency for on-site testing. In addition, referral laboratories should be instructed to store isolates in case additional testing is necessary.

All drug susceptibility results on *M. tuberculosis* isolates should be reported to the local or state health department as soon as these results are available. Laboratories that rarely receive specimens for mycobacteriologic analysis should refer specimens to a laboratory that performs these tests routinely. The reference

laboratory should provide rapid testing and reporting. Out-of-state reference laboratories should provide all results to the local or state health department from which the specimen originated.

Special Considerations for Persons Who Are at High Risk for TB Disease or in Whom TB Disease Might Be Difficult to Diagnose

The probability of TB disease is higher among patients who 1) previously had TB disease or were exposed to *M. tuberculosis*, 2) belong to a group at high risk for TB disease or, 3) have a positive TST or BAMT result. TB disease is strongly suggested if the diagnostic evaluation reveals symptoms or signs of TB disease, a chest radiograph consistent with TB disease, or AFB in sputum or from any other specimen. TB disease can occur simultaneously in immunocompromised persons who have pulmonary infections caused by other organisms (e.g., *Pneumocystis jiroveci* [formerly *P. carinii*] and *M. avium* complex) and should be considered in the diagnostic evaluation of all such patients with symptoms or signs of TB disease (CDC, 1998).

TB disease can be difficult to diagnose in persons who have HIV infection (Benson et al., 2004) (or other conditions associated with severe suppression of cell mediated immunity) because of nonclassical or normal radiographic presentation or the simultaneous occurrence of other pulmonary infections (e.g., *P. jiroveci or M. avium* complex) (Bennett et al., 2000). Patients who are HIV-infected are also at greater risk for having extrapulmonary TB (Bennett et al., 2000). The difficulty in diagnosing TB disease in HIV-infected can be compounded by the possible lower sensitivity and specificity of sputum smear results for detecting AFB (CDC, 1998; Klein et al., 1989) and the overgrowth of cultures with *M. avium* complex in specimens from patients infected with both *M. tuberculosis* and *M. avium* complex. The TST in patients with advanced HIV infection is unreliable and cannot be used in clinical decision making (CDC, "Guidelines for using the QuantiFERON®-TB," 2005; CDC, 1998; Pitchenik & Rubinson, 1985).

For immunocompromised patients who have respiratory symptoms or signs that are attributed initially to infections or conditions other than TB disease, conduct an evaluation for coexisting TB disease. If the patient does not respond to recommended treatment for the presumed cause of the pulmonary abnormalities, repeat the evaluation (see Supplement, "Diagnostic Procedures for LTBI and TB Disease" in the original guideline document). In certain settings in which immunocompromised patients and patients with TB disease are examined, implementing airborne precautions might be prudent for all persons at high risk. These persons include those infected with HIV who have an abnormal chest radiograph or respiratory symptoms, symptomatic foreign-born persons who have immigrated within the previous 5 years from TB-endemic countries, and persons with pulmonary infiltrates on chest radiograph, or symptoms or signs of TB disease.

Initiation of Treatment

For patients who have confirmed TB disease or who are considered highly probable to have TB disease, promptly start antituberculosis treatment in accordance with current guidelines (see Supplements, "Diagnostic Procedures for LTBI and TB Disease;" and "Treatment Procedures for LTBI and TB Disease" in the

original guideline document) ("Treatment of tuberculosis," 2003). In accordance with local and state regulations, local health departments should be notified of all cases of suspected TB.

DOT is the standard of care for all patients with TB disease and should be used for all doses during the course of therapy for treatment of TB disease. All inpatient medication should be administered by DOT and reported to the state or local health department. Rates of relapse and development of drug-resistance are decreased when DOT is used (Chaulk & Kazandjian, 1998; Frieden et al., 1995; Weis et al., 1994). All patients on intermittent (i.e., once or twice per week) treatment for TB disease or LTBI should receive DOT. Settings should collaborate with the local or state health department on decisions concerning inpatient DOT and arrangements for outpatient DOT ("Treatment of tuberculosis," 2003).

Managing Patients Who Have Suspected or Confirmed TB Disease: Considerations for Special Circumstances and Settings

The recommendations for preventing transmission of *M. tuberculosis* are applicable to all health-care settings, including those that have been described (see Appendix A in the original guideline document). These settings should each have independent risk assessments if they are stand-alone settings, or each setting should have a detailed section written as part of the risk assessment for the overall setting.

Minimum Requirements

The specific precautions for the settings included in this section vary, depending on the setting.

Inpatient Settings

Emergency Departments (EDs)

The symptoms of TB disease are usually symptoms for which patients might seek treatment in EDs. Because TB symptoms are common and nonspecific, infectious TB disease could be encountered in these settings. The use of ED-based TB screening has not been demonstrated to be consistently effective (Sokolove et al., 2000).

The amount of time patients with suspected or confirmed infectious TB disease spend in EDs and urgent-care settings should be minimized. Patients with suspected or confirmed infectious TB disease should be promptly identified, evaluated, and separated from other patients. Ideally, such patients should be placed in an AII room. When an AII room is not available, use a room with effective general ventilation, and use air cleaning technologies (e.g., a portable high-efficiency particulate air [HEPA] filtration system), if available, or transfer the patient to a setting or area with recommended infection-control capacity. Facility engineering personnel with expertise in heating, ventilation, and air conditioning (HVAC) and air handlers have evaluated how this option is applied to ensure no over pressurization of return air or unwanted alternations exists in design of air flow in the zone.

EDs with a high volume of patients with suspected or confirmed TB disease should have at least one AII room (see "TB risk assessment worksheet" [Appendix B] in the original guideline document). Air-cleaning technologies (e.g., HEPA filtration and ultraviolet germicidal irradiation [UVGI]) can be used to increase equivalent air changes per hour (ACH) in waiting areas (see Table 1 in the original guideline document). HCWs entering an AII room or any room with a patient with infectious TB disease should wear at least an N95 disposable respirator. After a patient with suspected or confirmed TB disease exits a room, allow adequate time to elapse to ensure removal of *M. tuberculosis*-contaminated room air before allowing entry by staff or another patient (see Supplement, "Environmental Controls" and Tables 1 and 2 in the original guideline document).

Before a patient leaves an AII room, perform an assessment of 1) the patient's need to discontinue airborne precautions, 2) the risk for transmission and the patient's ability to observe strict respiratory hygiene, and 3) cough etiquette procedures. Patients with suspected or confirmed infectious TB who are outside an AII room should wear a surgical or procedure mask, if possible. Patients who cannot tolerate masks because of medical conditions should observe strict respiratory hygiene and cough etiquette procedures.

Intensive Care Units (ICUs)

Patients with infectious TB disease might become sick enough to require admission to an ICU. Place ICU patients with suspected or confirmed infectious TB disease in an AII room, if possible. ICUs with a high volume of patients with suspected or confirmed TB disease should have at least one AII room (see "TB risk assessment worksheet," [Appendix B] in the original guideline document). Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase equivalent air changes per hour (ACH) in waiting areas (see Supplement, "Environmental Controls" in the original guideline document).

HCWs entering an AII room or any room with a patient with infectious TB disease should wear at least an N95 disposable respirator. To help reduce the risk for contaminating a ventilator or discharging *M. tuberculosis* into the ambient air when mechanically ventilating (i.e., with a ventilator or manual resuscitator) a patient with suspected or confirmed TB disease, place a bacterial filter on the patient's endotracheal tube (or at the expiratory side of the breathing circuit of a ventilator) (Aranha-Creado et al., 1997; Berry & Nolte, 1991; Demers, 2001; Langevin, Rand, & Layon, 1999; Tait, 1997). In selecting a bacterial filter, give preference to models specified by the manufacturer to filter particles 0.3 micron in size in both the unloaded and loaded states with a filter efficiency of >95% (i.e., filter penetration of <5%) at the maximum design flow rates of the ventilator for the service life of the filter, as specified by the manufacturer.

Surgical Suites

Surgical suites require special infection-control considerations for preventing transmission of *M. tuberculosis*. Normally, the direction of airflow should be from the operating room (OR) to the hallway (positive pressure) to minimize contamination of the surgical field. Certain hospitals have procedure rooms with reversible airflow or pressure, whereas others have positive-pressure rooms with a negative pressure anteroom. Surgical staff, particularly those close to the

surgical field, should use respiratory protection (e.g., a valveless N95 disposable respirator) to protect themselves and the patient undergoing surgery.

When possible, postpone non-urgent surgical procedures on patients with suspected or confirmed TB disease until the patient is determined to be noninfectious or determined to not have TB disease. When surgery cannot be postponed, procedures should be performed in a surgical suite with recommended ventilation controls. Procedures should be scheduled for patients with suspected or confirmed TB disease when a minimum number of HCWs and other patients are present in the surgical suite, and at the end of the day to maximize the time available for removal of airborne contamination (see Supplement, "Environmental Controls" and Tables 1 and 2 in the original guideline document).

If a surgical suite or an OR has an anteroom, the anteroom should be either 1) positive pressure compared with both the corridor and the suite or OR (with filtered supply air) or 2) negative pressure compared with both the corridor and the suite or OR. In the usual design in which an OR has no anteroom, keep the doors to the OR closed, and minimize traffic into and out of the room and in the corridor. Using additional air-cleaning technologies (e.g., UVGI) should be considered to increase the equivalent ACH. Air-cleaning systems can be placed in the room or in surrounding areas to minimize contamination of the surroundings after the procedure (Sehulster & Chinn, 2003) (see Supplement, "Environmental Controls" in the original guideline document).

Ventilation in the OR should be designed to provide a sterile environment in the surgical field while preventing contaminated air from flowing to other areas in the health-care setting. Personnel steps should be taken to reduce the risk for contaminating ventilator or anesthesia equipment or discharging tubercle bacilli into the ambient air when operating on a patient with suspected or confirmed TB disease (Teo & Lim, 2004). A bacterial filter should be placed on the patient's endotracheal tube (or at the expiratory side of the breathing circuit of a ventilator or anesthesia machine, if used) (Aranha-Creado et al., 1997; Berry & Nolte, 1991; Demers, 2001; Langevin, Rand, & Layon, 1999; Tait, 1997). When selecting a bacterial filter, give preference to models specified by the manufacturer to filter particles 0.3 micron in size in both the unloaded and loaded states with a filter efficiency of $\geq$95% (i.e., filter penetration of <5%) at the maximum design flow rates of the ventilator for the service life of the filter, as specified by the manufacturer.

When surgical procedures (or other procedures that require a sterile field) are performed on patients with suspected or confirmed infectious TB, respiratory protection should be worn by HCWs to protect the sterile field from the respiratory secretions of HCWs and to protect HCWs from the infectious droplet nuclei generated from the patient. When selecting respiratory protection, do not use valved or positive-pressure respirators, because they do not protect the sterile field. A respirator with a valveless filtering facepiece (e.g., N95 disposable respirator) should be used.

Postoperative recovery of a patient with suspected or confirmed TB disease should be in an AII room in any location where the patient is recovering (AIA, 2001). If an AII or comparable room is not available for surgery or postoperative recovery, air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase

the number of equivalent ACH (see Supplement, "Environmental Controls" in the original guideline document); however, the infection-control committee should be involved in the selection and placement of these supplemental controls.

Laboratories

Staff who work in laboratories that handle clinical specimens encounter risks not typically present in other areas of a health-care setting (Kao et al., 1997; Peerbooms et al., 1995; Garber et al., 2003). Laboratories that handle TB specimens include 1) pass-through facilities that forward specimens to reference laboratories for analysis; 2) diagnostic laboratories that process specimens and perform acid-fast staining and primary culture for *M. tuberculosis*; and 3) facilities that perform extensive identification, subtyping, and susceptibility studies.

Procedures involving the manipulation of specimens or cultures containing *M. tuberculosis* introduce additional substantial risks that must be addressed in an effective TB infection-control program. Personnel who work with mycobacteriology specimens should be thoroughly trained in methods that minimize the production of aerosols and undergo periodic competency testing to include direct observation of their work practices. Risks for transmission of *M. tuberculosis* in laboratories include aerosol formation during any specimen or isolate manipulation and percutaneous inoculation from accidental exposures. Biosafety recommendations for laboratories performing diagnostic testing for TB have been published (Menzies et al., 1995; Menzies et al., 2003; CDC & NIH, "Agent; *Mycobacterium tuberculosis*," 1999; Metchok, Nolte, & Wallace, 1999; Richmond, 2001).

In laboratories affiliated with a health-care setting (e.g., a hospital) and in free-standing laboratories, the laboratory director, in collaboration with the infection-control staff for the setting, and in consultation with the state TB laboratory, should develop a risk-based infection-control plan for the laboratory that minimizes the risk for exposure to *M. tuberculosis*. Consider factors including 1) incidence of TB disease (including drug-resistant TB) in the community and in patients served by settings that submit specimens to the laboratory, 2) design of the laboratory, 3) level of TB diagnostic service offered, 4) number of specimens processed, and 5) whether or not aerosol-generating or aerosol-producing procedures are performed and the frequency at which they are performed. Referral laboratories should store isolates in case additional testing is necessary.

Biosafety level (BSL)-2 practices and procedures, containment equipment, and facilities are required for nonaerosol-producing manipulations of clinical specimens (e.g., preparing direct smears for acid-fast staining when done in conjunction with training and periodic checking of competency) (CDC & NIH, "Agent: *Mycobacterium tuberculosis*," 1999). All specimens suspected of containing *M. tuberculosis* (including specimens processed for other microorganisms) should be handled in a Class I or II biological safety cabinet (BSC) (CDC & NIH, 2000; CDC & NIH, "Biosafety," 1999). Conduct all aerosol-generating activities (e.g., inoculating culture media, setting up biochemical and antimicrobic susceptibility tests, opening centrifuge cups, and performing sonication) in a Class I or II BSC (CDC & NIH, 2000).

For laboratories that are considered at least medium risk (see Appendix C in the original guideline document), conduct testing for *M. tuberculosis* infection at least

annually among laboratorians who perform TB diagnostics or manipulate specimens from which *M. tuberculosis* is commonly isolated (e.g., sputum, lower respiratory secretions, or tissues) (see Appendix D in the original guideline document). More frequent testing for *M. tuberculosis* is recommended in the event of a documented conversion among laboratory staff or a laboratory accident that poses a risk for exposure to *M. tuberculosis* (e.g., malfunction of a centrifuge leading to aerosolization of a sample).

Based on the risk assessment for the laboratory, employees should use personal protective equipment (including respiratory protection) recommended by local regulations for each activity. For activities that have a low risk for generating aerosols, standard personal protective equipment consists of protective laboratory coats, gowns, or smocks designed specifically for use in the laboratory. Protective garments should be left in the laboratory before going to nonlaboratory areas.

For all laboratory procedures, disposable gloves should be worn. Gloves should be disposed of when work is completed, the gloves are overtly contaminated, or the integrity of the glove is compromised. Local or state regulations should determine procedures for the disposal of gloves. Face protection (e.g., goggles, full-facepiece respirator, face shield, or other splatter guard) should also be used when manipulating specimens inside or outside a BSC. Use respiratory protection when performing procedures that can result in aerosolization outside a BSC. The minimum level of respiratory protection is an N95 filtering facepiece respirator. Laboratory workers who use respiratory protection should be provided with the same training on respirator use and care and the same fit testing as other HCWs.

After documented laboratory accidents, conduct an investigation of exposed laboratory workers. Laboratories in which specimens for mycobacteriologic studies (e.g., AFB smears and cultures) are processed should follow the AIA and CDC/National Institute of Health guidelines (AIA, 2001; CDC & NIH, "Biosafety," 1999) (see Supplement, "Environmental Controls" in the original guideline). BSL-3 practices, containment equipment, and facilities are recommended for the propagation and manipulation of cultures of *M. tuberculosis* complex (including *M. bovis*) and for animal studies in which primates that are experimentally or naturally infected with *M. tuberculosis* or *M. bovis* are used. Animal studies in which guinea pigs or mice are used can be conducted at animal BSL-2. Aerosol infection methods are recommended to be conducted at BSL-3 (CDC & NIH, "Biosafety," 1999).

Refer to the original guideline document for information on managing TB patients in bronchoscopy suites, sputum induction and inhalation therapy rooms, autopsy suites, and embalming rooms.

Outpatient Settings

Outpatient settings might include TB treatment facilities, dental-care settings, medical offices, ambulatory-care settings, and dialysis units. Environmental controls should be implemented based on the types of activities that are performed in the setting.

TB Treatment Facilities

TB treatment facilities might include TB clinics, infectious disease clinics, or pulmonary clinics. TB clinics and other settings in which patients with TB disease and LTBI are examined on a regular basis require special attention. The same principles of triage used in EDs and ambulatory-care settings (See Minimum Requirements) should be applied to TB treatment facilities. These principles include prompt identification, evaluation, and airborne precautions of patients with suspected or confirmed infectious TB disease.

All TB clinic staff, including outreach workers, should be screened for *M. tuberculosis* infection (see Appendix C in the original guideline document). Patients with suspected or confirmed infectious TB disease should be physically separated from all patients, but especially from those with HIV infection and other immunocompromising conditions that increase the likelihood of development of TB disease if infected. Immunosuppressed patients with suspected or confirmed infectious TB disease need to be physically separated from others to protect both the patient and others. Appointments should be scheduled to avoid exposing HIV-infected or otherwise severely immunocompromised persons to *M. tuberculosis*. Certain times of the day should be designated for appointments for patients with infectious TB disease or treat them in locations in areas in which immunocompromised persons are not treated.

Persons with suspected or confirmed infectious TB disease should be promptly placed in an AII room to minimize exposure in the waiting room and other areas of the clinic, and they should be instructed to observe strict respiratory hygiene and cough etiquette procedures. Clinics that provide care for patients with suspected or confirmed infectious TB disease should have at least one AII room. The need for additional AII rooms should be based on the risk assessment for the setting.

All cough-inducing and aerosol-generating procedures should be performed using environmental controls (e.g., in a booth or an AII room) (see Supplement, "Environmental Controls" in the original guideline document). Patients should be left in the booth or AII room until coughing subsides. Another patient or HCW should not be allowed to enter the booth or AII room until sufficient time has elapsed for adequate removal of *M. tuberculosis*-contaminated air (see Supplement, "Environmental Controls" in the original guideline document). A respiratory-protection program should be implemented for all HCWs who work in the TB clinic and who enter AII rooms, visit areas in which persons with suspected or confirmed TB disease are located, or transport patients with suspected or confirmed TB disease in vehicles. When persons with suspected or confirmed infectious TB disease are in the TB clinic and not in an AII room, they should wear a surgical or procedure mask, if possible.

Medical Offices and Ambulatory-Care Settings

The symptoms of TB disease are usually symptoms for which patients might seek treatment in a medical office. Therefore, infectious TB disease could possibly be encountered in certain medical offices and ambulatory-care settings.

Because of the potential for *M. tuberculosis* transmission in medical offices and ambulatory-care settings, follow the general recommendations for management of patients with suspected or confirmed TB disease and the specific

recommendations for EDs (see "Intensive Care Units [ICUs]" above). The risk assessment may be used to determine the need for or selection of environmental controls and the frequency of testing HCWs for *M. tuberculosis* infection.

Dialysis Units

Patients with ESRD who need chronic dialysis should have at least one test for *M. tuberculosis* infection to determine the need for treatment of LTBI. Annual re-screening is indicated if ongoing exposure of ESRD patients to *M. tuberculosis* is probable.

Hemodialysis procedures should be performed on hospitalized patients with suspected or confirmed TB disease in an AII room. Dialysis staff should use recommended respiratory protection, at least an N95 disposable respirator. Patients with suspected or confirmed TB disease who need chronic hemodialysis might need referral to a hospital or other setting with the ability to perform dialysis procedures in an AII room until the patient is no longer infectious or another diagnosis is made. Certain antituberculosis medications are prescribed differently for hemodialysis patients ("Targeted tuberculin testing," 2000).

Dental-Care Settings

To prevent the transmission of *M. tuberculosis* in dental-care settings, certain recommendations should be followed (Kohn et al., 2004; Kohn et al., 2003). Infection-control policies for each dental healthcare setting should be developed, based on the community TB risk assessment (see "TB risk assessment worksheet" [Appendix B] in the original guideline document), and should be reviewed annually, if possible. The policies should include appropriate screening for LTBI and TB disease for dental HCWs, education on the risk for transmission to the dental HCWs, and provisions for detection and management of patients who have suspected or confirmed TB disease.

When taking a patient's initial medical history and at periodic updates, dental HCWs should routinely document whether the patient has symptoms or signs of TB disease. If urgent dental care must be provided for a patient who has suspected or confirmed infectious TB disease, dental care should be provided in a setting that meets the requirements for an AII room (see Supplement, "Environmental Controls" in the original guideline document). Respiratory protection (at least N95 disposable respirator) should be used while performing procedures on such patients.

In dental health-care settings that routinely provide care to populations at high risk for TB disease, using engineering controls (e.g., portable HEPA units) similar to those used in waiting rooms or clinic areas of health-care settings with a comparable community-risk profile might be beneficial.

During clinical assessment and evaluation, a patient with suspected or confirmed TB disease should be instructed to observe strict respiratory hygiene and cough etiquette procedures (CDC, "Key facts," 2004). The patient should also wear a surgical or procedure mask, if possible. Non-urgent dental treatment should be postponed, and these patients should be promptly referred to an appropriate medical setting for evaluation of possible infectiousness. In addition, these

patients should be kept in the dental health-care setting no longer than required to arrange a referral.

Nontraditional Facility-Based Settings

Nontraditional facility-based settings include emergency medical services (EMS), medical settings in correctional facilities, home-based health-care and outreach settings, long-term-care settings (e.g., hospices and skilled nursing facilities), and homeless shelters. Environmental controls should be implemented based on the types of activities that are performed in the setting.

Because persons who visit homeless shelters frequently share exposure and risk characteristics of TB patients who are treated in outpatient clinics, homeless shelters with clinics should observe the same TB infection-control measures as outpatient clinics. Advisory Council for the Elimination of Tuberculosis (ACET) has developed recommendations to assist health-care providers, health departments, shelter operators and workers, social service agencies, and homeless persons to prevent and control TB in this population ("Prevention and control," 1992).

Emergency Medical Services (EMS)

EMS personnel should be included in a comprehensive screening program to test for *M. tuberculosis* infection and provide baseline screening and follow-up testing as indicated by the risk classification of the setting. Persons with suspected or confirmed infectious TB disease who are transported in an ambulance should wear a surgical or procedure mask, if possible, and drivers, HCWs, and other staff who are transporting the patient might consider wearing an N95 respirator.

The ambulance ventilation system should be operated in the nonrecirculating mode, and the maximum amount of outdoor air should be provided to facilitate dilution. If the vehicle has a rear exhaust fan, use this fan during transport. If the vehicle is equipped with a supplemental recirculating ventilation unit that passes air through HEPA filters before returning it to the vehicle, use this unit to increase the number of ACH (CDC, "Guidelines for infection control," 2003). Air should flow from the cab (front of vehicle), over the patient, and out the rear exhaust fan. If an ambulance is not used, the ventilation system for the vehicle should bring in as much outdoor air as possible, and the system should be set to nonrecirculating. If possible, physically isolate the cab from the rest of the vehicle, and place the patient in the rear seat (Seitz, Decker, & Jensen, 1996).

EMS personnel should be included in the follow-up contact investigations of patients with infectious TB disease. The Ryan White Comprehensive AIDS Resource Emergency Act of 1990 (Public law 101-381) mandates notification of EMS personnel after they have been exposed to a patient with suspected or confirmed infectious TB disease (Title 42 U.S. Code 1994) (http://hab.hrsa.gov/data2/adap/introduction.htm).

Refer to the original guideline document for information regarding medical settings in:

- Correctional facilities

- Home-based health-care and outreach settings
- Long-term-care facilities (LTCFs)

Training and Educating HCWs

HCW training and education regarding infection with *M. tuberculosis* and TB disease is an essential part of administrative controls in a TB surveillance or infection-control program. Training physicians and nurse managers is especially essential because of the leadership role they frequently fulfill in infection control. HCW training and education can increase adherence to TB infection-control measures. Training and education should emphasize the increased risks posed by an undiagnosed person with TB disease in a health-care setting and the specific measures to reduce this risk. HCWs receive various types of training; therefore, combining training for TB infection control with other related trainings might be preferable.

Initial TB Training and Education

The setting should document that all HCWs, including physicians, have received initial TB training relevant to their work setting and additional occupation-specific education. The level and detail of baseline training will vary according to the responsibilities of the HCW and the risk classification of the setting.

Educational materials on TB training are available from various sources at no cost in printed copy, on videotape (CDC, "Mantoux," 2003), on compact discs, and the Internet. The local or state health department should have access to additional materials and resources and might be able to help develop a setting-specific TB education program. Suggested components of a baseline TB training program for HCWs have been described previously (see the original guideline document). CDC's TB website provides information regarding training and education materials (http://www.cdc.gov/tb). Additional training and education materials are available on CDC's TB Education and Training Resources website (http://www.findtbresources.org) and on other TB-related websites and resources (see Appendix E in the original guideline document).

Physicians, trainees, students, and other HCWs who work in a health-care setting but do not receive payment from that setting should receive baseline training in TB infection-control policies and practices, the TB screening program, and procedures for reporting an *M. tuberculosis* infection test conversion or diagnosis of TB disease. Initial TB training should be provided before the HCW starts working.

Follow-Up TB Training and Education

All settings should conduct an annual evaluation of the need for follow-up training and education for HCWs based on the number of untrained and new HCWs, changes in the organization and services of the setting, and availability of new TB infection-control information.

If a potential or known exposure to *M. tuberculosis* occurs in the setting, prevention and control measures should include retraining HCWs in the infection-

control procedures established to prevent the recurrence of exposure. If a potential or known exposure results in a newly recognized positive TST or BAMT result, test conversion, or diagnosis of TB disease, education should include information on 1) transmission of *M. tuberculosis*, 2) noninfectiousness of HCWs with LTBI, and 3) potential infectiousness of HCWs with TB disease.

Occupational Safety and Health Administration (OSHA) requires annual respiratory-protection training for HCWs who use respiratory devices (see Supplement, "Respiratory Protection"). HCWs in settings with a classification of potential ongoing transmission should receive additional training and education on 1) symptoms and signs of TB disease, 2) *M. tuberculosis* transmission, 3) infection-control policies, 4) importance of TB screening for HCWs, and 5) responsibilities of employers and employees regarding *M. tuberculosis* infection test conversion and diagnosis of TB disease.

TB Infection-Control Surveillance

HCW Screening Programs for TB Support Surveillance and Clinical Care

TB screening programs provide critical information for caring for individual HCWs and information that facilitates detection of *M. tuberculosis* transmission. The screening program consists of four major components: 1) baseline testing for *M. tuberculosis* infection, 2) serial testing for *M. tuberculosis* infection, 3) serial screening for symptoms or signs of TB disease, and 4) TB training and education.

Surveillance data from HCWs can protect both HCWs and patients. Screening can prevent future transmission by identifying lapses in infection control and expediting treatment for persons with LTBI or TB disease. Tests to screen for *M. tuberculosis* infection should be administered, interpreted, and recorded according to procedures in this report (see Supplement, "Diagnostic Procedures for LTBI and TB Disease" in the original guideline document). Protection of privacy and maintenance of confidentiality of HCW test results should be ensured. Methods to screen for infection with *M. tuberculosis* are available ("Diagnostic standards," 2000; "Treatment of tuberculosis," 2003; "Targeted tuberculin testing," 2000).

Baseline Testing for M. tuberculosis Infection

Baseline testing for *M. tuberculosis* infection is recommended for all newly hired HCWs, regardless of the risk classification of the setting and can be conducted with the TST or BAMT. Baseline testing is also recommended for persons who will receive serial TB screening (e.g., residents or staff of correctional facilities or LTCFs) ("Targeted tuberculin testing," 2000; Snider & Cauthen, 1984). Certain settings, with the support of the infection-control committee, might choose not to perform baseline or serial TB screening for HCWs who will never be in contact with or have shared air space with patients who have TB disease (e.g., telephone operators who work in a separate building from patients) or who will never be in contact with clinical specimens that might contain *M. tuberculosis*.

Baseline test results 1) provide a basis for comparison in the event of a potential or known exposure to *M. tuberculosis* and 2) facilitate the detection and treatment of LTBI or TB disease in an HCW before employment begins and reduces the risk to patients and other HCWs. If TST is used for baseline testing, two-step testing is

recommended for HCWs whose initial TST results are negative ("Targeted tuberculin testing," 2000; Snider & Cauthen, 1984). If the first-step TST result is negative, the second-step TST should be administered 1 to 3 weeks after the first TST result was read. If either 1) the baseline first-step TST result is positive or 2) the first-step TST result is negative but the second-step TST result is positive, TB disease should be excluded, and if it is excluded, then the HCW should be evaluated for treatment of LTBI. If the first and second-step TST results are both negative, the person is classified as not infected with *M. tuberculosis*.

If the second test result of a two-step TST is not read within 48 to 72 hours, administer a TST as soon as possible (even if several months have elapsed) and ensure that the result is read within 48 to 72 hours ("Targeted tuberculin testing," 2000). Certain studies indicate that positive TST reactions might still be measurable from 4 to 7 days after testing (Duboczy & Brown, 1961; Cobelens et al., 2003). However, if a patient fails to return within 72 hours and has a negative test result, the TST should be repeated (CDC, "Core Curriculum," 2000).

A positive result to the second step of a baseline two-step TST is probably caused by boosting as opposed to recent infection with *M. tuberculosis*. These responses might result from remote infections with *M. tuberculosis*, infection with an nontuberculosis mycobacteria (NTM) (also known as mycobacterium other than tuberculosis [MOTT]), or previous bacille Calmette-Guerin (BCG) vaccination. Two-step testing will minimize the possibility that boosting will lead to an unwarranted suspicion of transmission of *M. tuberculosis* with subsequent testing. A second TST is not needed if the HCW has a documented TST result from any time during the previous 12 months (see "Baseline Testing for *M. tuberculosis* Infection After TST Within the Previous 12 Months" below).

A positive TST reaction as a result of BCG wanes after 5 years. Therefore, HCWs with previous BCG vaccination will frequently have a negative TST result (Menzies et al., 1995; CDC, 1996; Huebner, Schein, & Bass, 1993; Karalliedde, Katugaha, & Uragoda, 1987; Mazurek et al., 2001; Menzies & Vissandjee, 1992; Snider, 1985). Because HCWs with a history of BCG are frequently from high TB-prevalence countries, positive test results for *M. tuberculosis* infection in HCWs with previous BCG vaccination should be interpreted as representing infection with *M. tuberculosis* (Menzies et al., 1995; CDC, 1996; Huebner, Schein, & Bass, 1993; Karalliedde, Katugaha, & Uragoda, 1987; Mazurek et al., 2001; Menzies & Vissandjee, 1992; Snider, 1985; Bugiani et al., 2003). Although BCG reduces the occurrence of severe forms of TB disease in children and overall might reduce the risk for progression from LTBI to TB disease (Aronson et al., 2004; Dye, 2004), BCG is not thought to prevent *M. tuberculosis* infection (Fine et al., 1999). Test results for *M. tuberculosis* infection for HCWs with a history of BCG should be interpreted by using the same diagnostic cut points used for HCWs without a history of BCG vaccination.

BAMT does not require two-step testing and is more specific than skin testing. BAMT that uses *M. tuberculosis* specific antigens (e.g., QuantiFERON-TB Gold test [QFT-G]) are not expected to result in false-positive results in persons vaccinated with BCG. Baseline test results should be documented, preferably within 10 days of HCWs starting employment.

Baseline Testing for M. tuberculosis Infection After TST Within the Previous 12 Months

A second TST is not needed if the HCW has a documented TST result from any time during the previous 12 months. If a newly employed HCW has had a documented negative TST result within the previous 12 months, a single TST can be administered in the new setting (see Box 1 "Indications for two-step tuberculin skin tests (TSTs)" in the original guideline document). This additional TST represents the second stage of two-step testing. The second test decreases the possibility that boosting on later testing will lead to incorrect suspicion of transmission of *M. tuberculosis* in the setting.

A recent TST (performed in $\leq$12 months) is not a contraindication to a subsequent TST unless the test was associated with severe ulceration or anaphylactic shock, which are substantially rare adverse events ("Diagnostic standards," 2000; Aventis Pasteur, 2001; Parkdale Pharmaceuticals, 2002; Froeschle, Ruben, & Bloh, 2002). Multiple TSTs are safe and do not increase the risk for a false-positive result or a TST conversion in persons without infection with mycobacteria ("Targeted tuberculin testing," 2000).

Baseline Documentation of a History of TB Disease, a Previously Positive Test Result for M. tuberculosis Infection, or Completion of Treatment for LTBI or TB Disease

Additional tests for *M. tuberculosis* infection do not need to be performed for HCWs with a documented history of TB disease, documented previously positive test result for *M. tuberculosis* infection, or documented completion of treatment for LTBI or TB disease. Documentation of a previously positive test result for *M. tuberculosis* infection can be substituted for a baseline test result if the documentation includes a recorded TST result in millimeters (or BAMT result), including the concentration of cytokine measured (e.g., IFN-gamma). All other HCWs should undergo baseline testing for *M. tuberculosis* infection to ensure that the test result on record in the setting has been performed and measured using the recommended diagnostic procedures (see Supplement, "Diagnostic Procedures for LTBI and TB Disease" in the original guideline document).

A recent TST (performed in $\leq$12 months) is not a contraindication to the administration of an additional test unless the TST was associated with severe ulceration or anaphylactic shock, which are substantially rare adverse events ("Diagnostic standards," 2000; Aventis Pasteur, 2001; Parkdale Pharmaceuticals, 2002). However, the recent test might complicate interpretation of subsequent test results because of the possibility of boosting.

Serial Follow-Up of TB Screening and Testing for M. tuberculosis Infection

The need for serial follow-up screening for groups of HCWs with negative test results for *M. tuberculosis* infection is an institutional decision that is based on the setting's risk classification. This decision and changes over time based on updated risk assessments should be official and documented. If a serial follow-up screening program is required, the risk assessment for the setting (see "TB risk assessment worksheet" [Appendix B] in the original guideline document) will

determine which HCWs should be included in the program and the frequency of screening. Two-step TST testing should not be performed for follow-up testing.

If possible, stagger follow-up screening (rather than testing all HCWs at the same time each year) so that all HCWs who work in the same area or profession are not tested in the same month. Staggered screening of HCWs (e.g., on the anniversary of their employment or on their birthdays) increases opportunities for early recognition of infection-control problems that can lead to conversions in test results for *M. tuberculosis* infection. Processing aggregate analysis of TB screening data on a periodic regular basis is important for detecting problems.

HCWs with a Newly Recognized Positive Test Result for M. tuberculosis Infection or Symptoms or Signs of TB Disease

Clinical Evaluation

Any HCW with a newly recognized positive test result for *M. tuberculosis* infection, test conversion, or symptoms or signs of TB disease should be promptly evaluated. The evaluation should be arranged with employee health, the local or state health department, or a personal physician. Any physicians who evaluate HCWs with suspected TB disease should be familiar with current diagnostic and therapeutic guidelines for LTBI and TB disease ("Treatment of tuberculosis," 2003; "Targeted tuberculin testing," 2000).

The definitions for positive test results for *M. tuberculosis* infection and test conversion in HCWs are included in this report (see Supplement, "Diagnostic Procedures for LTBI and TB Disease" in the original guideline document). Symptoms of disease in the lung, pleura, or airways, and the larynx include coughing for >3 weeks, loss of appetite, unexplained weight loss, night sweats, bloody sputum or hemoptysis, hoarseness, fever, fatigue, or chest pain. The evaluation should include a clinical examination and symptom screen (a procedure used during a clinical evaluation in which patients are asked if they have experienced any symptoms or signs of TB disease), chest radiograph, and collection of sputum specimens.

If TB disease is diagnosed, begin antituberculosis treatment immediately, according to published guidelines ("Treatment of tuberculosis," 2003). The diagnosing clinician (who might not be a physician with the institution's infection-control program) should notify the local or state health department in accordance with disease reporting laws, which generally specify a 24-hour time limit.

If TB disease is excluded, offer the HCW treatment for LTBI in accordance with published guidelines (see Supplements, "Diagnostic Procedures for LTBI and TB Disease" in the original guideline document; and "Treatment Procedures for LTBI and TB Disease" ["Targeted tuberculin testing," 2000; CDC & ATS, 2003]). If the HCW has already completed treatment for LTBI and is part of a TB screening program, instead of participating in serial skin testing, the HCW should be monitored for symptoms of TB disease and should receive any available training, which should include information on the symptoms of TB disease and instructing the HCW to report any such symptoms immediately to occupational health. In addition, annual symptom screens should be performed, which can be administered as part of other HCW screening and education efforts. Treatment for

LTBI should be offered to HCWs who are eligible ("Targeted tuberculin testing," 2000).

HCWs with a previously negative test result who have an increase of ≥10 mm induration when examined on follow-up testing probably have acquired *M. tuberculosis* infection and should be evaluated for TB disease. When disease is excluded, HCWs should be treated for LTBI unless medically contraindicated ("Targeted tuberculin testing," 2000; CDC & ATS, 2003).

Chest Radiography

HCWs with a baseline positive or newly positive TST or BAMT result should receive one chest radiograph to exclude a diagnosis of TB disease (or an interpretable copy within a reasonable time frame, such as 6 months). After this baseline chest radiograph is performed and the result is documented, repeat radiographs are not needed unless symptoms or signs of TB disease develop or a clinician recommends a repeat chest radiograph ("Targeted tuberculin testing," 2000; Food and Drug Administration, 1983). Instead of participating in serial testing for *M. tuberculosis* infection, HCWs with a positive test result for *M. tuberculosis* infection should receive a symptom screen. The frequency of this symptom screen should be determined by the risk classification for the setting.

Serial follow-up chest radiographs are not recommended for HCWs with documentation of a previously positive test result for *M. tuberculosis* infection, treatment for LTBI or TB disease, or for asymptomatic HCWs with negative test results for *M. tuberculosis* infection. HCWs who have a previously positive test result for *M. tuberculosis* infection and who change jobs should carry documentation of a baseline chest radiograph result (and the positive test result for *M. tuberculosis* infection) to their new employers.

Workplace Restrictions

HCWs with a baseline positive or newly positive test result for *M. tuberculosis* infection should receive one chest radiograph result to exclude TB disease (or an interpretable copy within a reasonable time frame, such as 6 months).

HCWs with confirmed infectious pulmonary, laryngeal, endobroncheal, or tracheal TB disease, or a draining TB skin lesion pose a risk to patients, HCWs, and others. Such HCWs should be excluded from the workplace and should be allowed to return to work when the following criteria have been met: 1) three consecutive sputum samples (Al Zahrani, et al., 2001; Conde et al., 2000; Bell, Leckie, & McKendrick, 2003; Merrick et al., 1997) collected in 8- to 24-hour intervals that are negative, with at least one sample from an early morning specimen (because respiratory secretions pool overnight); 2) the person has responded to antituberculosis treatment that will probably be effective (can be based on susceptibility results); and 3) the person is determined to be noninfectious by a physician knowledgeable and experienced in managing TB disease (see Supplements, "Estimating the Infectiousness of a TB Patient;" "Diagnostic Procedures for LTBI and TB Disease;" and "Treatment Procedures for LTBI and TB Disease" in the original guideline document).

HCWs with extrapulmonary TB disease usually do not need to be excluded from the workplace as long as no involvement of the respiratory track has occurred. They can be confirmed as noninfectious and can continue to work if documented evidence is available that indicates that concurrent pulmonary TB disease has been excluded.

HCWs receiving treatment for LTBI can return to work immediately. HCWs with LTBI who cannot take or do not accept or complete a full course of treatment for LTBI should not be excluded from the workplace. They should be counseled regarding the risk for developing TB disease and instructed to report any TB symptoms immediately to the occupational health unit.

HCWs who have a documented positive TST or BAMT result and who leave employment should be counseled again, if possible, regarding the risk for developing TB disease and instructed to seek prompt evaluation with the local health department or their primary care physician if symptoms of TB disease develop. Consider mailing letters to former HCWs who have LTBI. This information should be recorded in the HCWs' employee health record when they leave employment.

Asymptomatic HCWs with a baseline positive or newly positive TST or BAMT result do not need to be excluded from the workplace. Treatment for LTBI should be considered in accordance with CDC guidelines ("Targeted tuberculin testing," 2000).

Identification of Source Cases and Recording of Drug-Susceptibility Patterns

If an HCW experiences a conversion in a test result for *M. tuberculosis* infection, evaluate the HCW for a history of suspected or known exposure to *M. tuberculosis* to determine the potential source. When the source case is identified, also identify the drug susceptibility pattern of the *M. tuberculosis* isolate from the source. The drug-susceptibility pattern should be recorded in the HCW's medical or employee health record to guide the treatment of LTBI or TB disease, if indicated.

HCWs with Medical Conditions Associated with Increased Risk for Progression to TB Disease

In settings in which HCWs are severely immunocompromised additional precautions must be taken. Refer to the original guideline document for additional information on HCWs with medical conditions associated with increased risk for progression to TB disease.

Problem Evaluation

Contact investigations might be initiated in response to 1) conversions in test results in HCWs for *M. tuberculosis* infection, 2) diagnosis of TB disease in an HCW, 3) suspected person-to-person transmission of *M. tuberculosis*, 4) lapses in TB infection-control practices that expose HCWs and patients to *M. tuberculosis*, or 5) possible TB outbreaks identified using automated laboratory systems (Widdowson et al., 2003). In these situations, the objectives of a contact investigation might be to 1) determine the likelihood that transmission of *M.*

tuberculosis has occurred; 2) determine the extent of *M. tuberculosis* transmission; 3) identify persons who were exposed, and, if possible, the sources of potential transmission; 4) identify factors that could have contributed to transmission, including failure of environmental infection-control measures, failure to follow infection-control procedures, or inadequacy of current measures or procedures; 5) implement recommended interventions; 6) evaluate the effectiveness of the interventions; and 7) ensure that exposure to *M. tuberculosis* has been terminated and that the conditions leading to exposure have been eliminated.

Earlier recognition of a setting in which *M. tuberculosis* transmission has occurred could be facilitated through innovative approaches to TB contact investigations (e.g., network analysis and genetic typing of isolates). Network analysis makes use of information (e.g., shared locations within a setting that might not be collected in traditional TB contact investigations) (McElroy et al., "A network informed," 2003). This type of information might be useful during contact investigations involving hospitals or correctional settings to identify any shared wards, hospital rooms, or cells. Genotyping of isolates is universally available in the United States and is a useful adjunct in the investigation of *M. tuberculosis* transmission (McElroy et al., "Outbreak of tuberculosis among homeless persons coinfected with human immunodeficiency virus", 2003; Nivin et al., 2002; Malakmadze et al., 2005; Nardell et al., 1986). Because the situations prompting an investigation are likely to vary, investigations should be tailored to the individual circumstances. Recommendations provide general guidance for conducting contact investigations (CDC, "Guidelines for the investigation", 2005; CDC," Effective TB," 2004).

General Recommendations for Investigating Conversions in Test Results for M. tuberculosis Infection in HCWs

A test conversion might need to be reported to the health department, depending on state and local regulations. Problem evaluation during contact investigations should be accomplished through cooperation between infection-control personnel, occupational health, and the local or state TB-control program. If a test conversion in an HCW is detected as a result of serial screening and the source is not apparent, conduct a source case investigation to determine the probable source and the likelihood that transmission occurred in the health-care setting (CDC, "Effective TB," 2004).

Lapses in TB infection control that might have contributed to the transmission of *M. tuberculosis* should be corrected. Test conversions and TB disease among HCWs should be recorded and reported, according to OSHA requirements (http://www.osha.gov/recordkeeping). Consult *Recording and Reporting Occupational Injuries and Illness* (OSHA standard 29 Code of Federal Regulations [CFR], 1904) to determine recording and reporting requirements (Occupational Safety and Health Administration, 2003).

Refer to the original guideline document for further details on the following topics:

- Investigating conversions in test results for *M. tuberculosis* Infection in HCWs: Probable source outside the health-care setting

- Investigating conversions in test results for *M. tuberculosis* infection in HCWs: Known source in the health-care setting
- Investigating a conversion of a test result for M. tuberculosis infection in an HCW with an unknown exposure
- Investigations that do not identify a probable source
- Conversions in test results for *M. tuberculosis* infection detected in follow-up testing
- Investigating a case of TB disease in an HCW
- Investigating possible patient-to-patient transmission of *M. tuberculosis*
- Surveillance of TB cases in patients indicates possible patient-to-patient transmission of *M. tuberculosis*
- Contact investigations

Collaboration with the Local or State Health Department

For assistance with the planning and implementation of TB-control activities in the health-care setting and for names of experts to help with policies, procedures, and program evaluation, settings should coordinate with the local or state TB-control program. By law, the local or state health department must be notified when TB disease is suspected or confirmed in a patient or HCW so that follow up can be arranged and a community contact investigation can be conducted. The local or state health department should be notified as early as possible before the patient is discharged to facilitate follow-up and continuation of therapy by DOT ("Treatment of tuberculosis," 2003). For inpatient settings, coordinate a discharge plan with the patient (including a patient who is an HCW with TB disease) and the TB-control program of the local or state health department.

Environmental Controls

Environmental controls are the second line of defense in the TB infection-control program, after administrative controls. Environmental controls include technologies for the removal or inactivation of airborne *M. tuberculosis*. These technologies include local exhaust ventilation, general ventilation, HEPA filtration, and UVGI. These controls help to prevent the spread and reduce the concentration of infectious droplet nuclei in the air. A summary of environmental controls and their use in prevention of transmission of *M. tuberculosis* is provided in the Supplement section of the original guideline document, including detailed information concerning the application of environmental controls.

Refer to the original guideline document for more detailed information on the following environmental control topics:

- Local exhaust ventilation
- General ventilation
- Hepa filters
- UVGI

Program Issues

Personnel from engineering, maintenance, safety and infection control, and environmental health should collaborate to ensure the optimal selection, installation, operation, and maintenance of environmental controls. A written

maintenance plan should be developed that outlines the responsibility and authority for maintenance of the environmental controls and addresses HCW training needs. Standard operating procedures should include the notification of infection-control personnel before performing maintenance on ventilation systems servicing TB patient-care areas.

Personnel should schedule routine preventive maintenance for all components of the ventilation systems (e.g., fans, filters, ducts, supply diffusers, and exhaust grills) and air-cleaning devices. Quality control (QC) checks should be conducted to verify that environmental controls are operating as designed and that records are current. Provisions for emergency electrical power should be made so that the performance of essential environmental controls is not interrupted during a power failure.

Respiratory Protection

The first two levels of the infection-control hierarchy, administrative and environmental controls, minimize the number of areas in which exposure to *M. tuberculosis* might occur. In addition, these administrative and environmental controls also reduce, but do not eliminate, the risk in the few areas in which exposures can still occur (e.g., AII rooms and rooms where cough-inducing or aerosol-generating procedures are performed). Because persons entering these areas might be exposed to airborne *M. tuberculosis*, the third level of the hierarchy is the use of respiratory protective equipment in situations that pose a high risk for exposure (see Supplement, "Respiratory Protection" in the original guideline document).

Refer to the original guideline for information regarding indications for respiratory protection use.

Respiratory-Protection Program

OSHA requires health-care settings in which HCWs use respiratory protection to develop, implement, and maintain a respiratory-protection program. All HCWs who use respiratory protection should be included in the program (see Supplement, "Respiratory Protection" in the original guideline document).

Refer to the original guideline document for information regarding:

- Training HCWS
- Selection of respirators
- Fit testing

Respirator Options: General Recommendations

In situations that require respiratory protection, the minimum respiratory protection device is a filtering facepiece (nonpowered, air-purifying, half-facepiece) respirator (e.g., an N95 disposable respirator). This CDC/NIOSH-certified respirator meets the minimum filtration performance for respiratory protection in areas in which patients with suspected or confirmed TB disease might be encountered. For situations in which the risk for exposure to *M.*

tuberculosis is especially high because of cough-inducing and aerosol-generating procedures, more protective respirators might be needed (see "Respirator Options: Special Circumstances" in the original guideline document).

Cough-Inducing and Aerosol-Generating Procedures

General Recommendations

Procedures that involve instrumentation of the lower respiratory tract or induction of sputum can increase the likelihood that droplet nuclei will be expelled into the air. These cough-inducing procedures include endotracheal intubation, suctioning, diagnostic sputum induction, aerosol treatments (e.g., pentamidine therapy and nebulized treatments), bronchoscopy, and laryngoscopy; gastric aspiration and nasogastric tube placement can also induce cough in certain patients. Other procedures that can generate aerosols include irrigating TB abscesses, homogenizing or lyophilizing tissue, performing autopsies on cadavers with untreated TB disease, and other processing of tissue that might contain tubercle bacilli and TB laboratory procedures.

If possible, postpone cough-inducing or aerosol-generating procedures on patients with suspected or confirmed infectious TB disease unless the procedure can be performed with recommended precautions. When a cough-inducing or aerosol-generating procedure must be performed on a patient with suspected or confirmed infectious TB disease, use a local exhaust ventilation device (e.g., booth or special enclosure). If using this device is not feasible, perform the procedure in a room that meets the ventilation requirements for an AII room.

After completion of cough-inducing procedures, keep patients in the AII room or enclosure until coughing subsides. Patients should be given tissues and instructed to cover the mouth and nose with tissues when coughing. Tissues should be disposed of in accordance with the infection-control plan.

Before the booth, enclosure, or room is used for another patient, allow enough time for the removal of $\geq$99% of airborne contaminants. This interval will vary based on the efficiency of the ventilation or filtration system (see Supplement, "Environmental Controls" and Table 2 in the original guideline document).

For postoperative recovery, do not place the patient in a recovery room with other patients; place the patient in a room that meets the ventilation requirements for an AII room. If the room does not meet the ventilation requirements for an AII room, air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH (see Supplement, "Environmental Controls" in the original guideline document).

Perform all manipulations of suspected or confirmed *M. tuberculosis* specimens that might generate aerosols in a BSC. When in rooms or enclosures in which cough-inducing or aerosol-generating procedures are being performed, respiratory protection should be worn.

Refer to the original guideline document for the following:

- Special considerations for bronchoscopy
- Special considerations for administration of aerosolized pentamidine and other medications

Refer to the Supplement section in the original guideline document for more information on the following topics:

- Estimating the infectiousness of a TB patient
- Diagnostic procedures for LTBI and TB disease
- Treatment procedures for LTBI and TB disease
- Surveillance and detection of *M. tuberculosis* infections in health-care settings
- Environmental controls
- Respiratory protection
- Cleaning, disinfecting, and sterilizing patient-care equipment and rooms

CLINICAL ALGORITHM(S)

None provided

EVIDENCE SUPPORTING THE RECOMMENDATIONS

REFERENCES SUPPORTING THE RECOMMENDATIONS

References open in a new window

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The Centers for Disease Control and Prevention (CDC) prepared the guidelines in this report in consultation with experts in tuberculosis (TB), infection control, environmental control, respiratory protection, and occupational health. Primary references citing evidence-based science are used in this report to support explanatory material and recommendations. Review articles, which include primary references, are used for editorial style and brevity.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Prevention of another tuberculosis (TB) resurgence and elimination of the lingering threat to health-care workers (HCWs), which is primarily from patients or other persons with unsuspected and undiagnosed infectious TB disease

Subgroups Most Likely to Benefit

In addition to close contacts, the following persons are also at higher risk for exposure to and infection with *M. tuberculosis*. Persons listed who are also close contacts should be top priority.

- Foreign-born persons, including children, especially those who have arrived to the United States within 5 years after moving from geographic areas with a

high incidence of TB disease (e.g., Africa, Asia, Eastern Europe, Latin America, and Russia) or who frequently travel to countries with a high prevalence of TB disease.
- Residents and employees of congregate settings that are high risk (e.g., correctional facilities, long-term-care facilities [LTCFs], and homeless shelters).
- Health-care workers (HCWs) who serve patients who are at high risk.
- HCWs with unprotected exposure to a patient with TB disease before the identification and correct airborne precautions of the patient.
- Certain populations who are medically underserved and who have low income, as defined locally.
- Populations at high risk who are defined locally as having an increased incidence of TB disease.
- Infants, children, and adolescents exposed to adults in high-risk categories.

Persons Whose Condition is at High Risk for Progression From LTBI to TB Disease

The following persons are at high risk for progressing from Latent Tuberculosis Infection (LTB)I to TB disease:

- Persons infected with human immunodeficiency virus (HIV)
- Persons infected with *M. tuberculosis* within the previous 2 years
- Infants and children aged <4 years
- Persons with any of the following clinical conditions or other immunocompromising conditions
    - Silicosis
    - Diabetes mellitus
    - Chronic renal failure
    - Certain hematologic disorders (leukemias and lymphomas)
    - Other specific malignancies (e.g., carcinoma of the head, neck, or lung)
    - Body weight $\geq$10% below ideal body weight
    - Prolonged corticosteroid use
    - Other immunosuppressive treatments (including tumor necrosis factor-alpha [TNFa] antagonists)
    - Organ transplant
    - End-stage renal disease (ESRD)
    - Intestinal bypass or gastrectomy
- Persons with a history of untreated or inadequately treated TB disease, including persons with chest radiograph findings consistent with previous TB disease.

Persons who use tobacco or alcohol, illegal drugs, including injection drugs and crack cocaine, might also be at increased risk for infection and disease. However, because of multiple other potential risk factors that commonly occur among such persons, use of these substances has been difficult to identify as separate risk factors.

POTENTIAL HARMS

- False-positive and false-negative tuberculin skin tests for *Mycobacterium tuberculosis*
- Adverse effect of therapy for tuberculosis

CONTRAINDICATIONS

CONTRAINDICATIONS

- A previous tuberculin skin test (TST) is not a contraindication to a subsequent TST unless the test was associated with severe ulceration or anaphylactic shock, which are substantially rare adverse events.
- Persons who might not be good candidates for treatment of latent tuberculosis infection (LTBI) include those with a previous history of liver injury or a history of excessive alcohol consumption. Active hepatitis and end-stage liver disease are relative contraindications to the use of isoniazid (INH) for treatment of LTBI. If the decision is made to treat such patients, baseline and follow-up monitoring of serum aminotransaminases should be considered.
- Reports of severe liver injury and death associated with the combination of rifampin and pyrazinamide (RZ) for treatment of LTBI prompted the American Thoracic Society and the Centers for Disease Control and Prevention (CDC) to revise previous recommendations to indicate that RZ generally should not be offered for the treatment of LTBI. If the potential benefits substantially outweigh the demonstrated risk for severe liver injury and death associated with this regimen and the patient has no contraindications, a physician with experience treating LTBI and TB disease should be consulted before using this regimen. Clinicians should continue the appropriate use of rifampin and pyrazinamide in standard multidrug antituberculosis treatment regimens for the treatment of TB disease.
- Latex allergy can be a contraindication to skin testing if the allergy is severe and the products used to perform the test (e.g., syringe plungers, PPD antigen bottle stopper, and gloves) contain latex.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

Refer to the Major Recommendations field and the Supplement section in the original guideline document for detailed information regarding implementation strategy.

IMPLEMENTATION TOOLS

Chart Documentation/Checklists/Forms
Staff Training/Competency Material

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better
Staying Healthy

IOM DOMAIN

Effectiveness
Patient-centeredness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

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GUIDELINE STATUS

This is the current release of the guideline.

GUIDELINE AVAILABILITY

Electronic copies: Available from the Centers for Disease Control and Prevention (CDC) Web site:

- HTML Format
- Portable Document Format (PDF)

Print copies: Available from the Centers for Disease Control and Prevention, MMWR, Atlanta, GA 30333. Additional copies can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325; (202) 783-3238.

AVAILABILITY OF COMPANION DOCUMENTS

A variety of implementation tools, including a risk assessment worksheet, procedural observation checklist, medical evaluation request, and a questionnaire for users of N95 respirators are available in the appendices to the original guideline document.

A Continuing Education activity is also available at CDC Website.

PATIENT RESOURCES

None available

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